been so well described. Of the linnet, too, he says most truly that it has one note, and only one, of almost unapproachable musical beauty. The singing of the skylarks, that invariable accompaniment of down life, is described with all Mr. Hudson's wonderful sympathy and delicacy of language ; but what are we to say of his belief that the highest notes of this bird may be heard on the downs at a distance of three miles ? It is a belief which it would hardly be possible to test.

"The Birds of Cheshire" is an excellent book of its kind. The first essential of such a compilation is that it should be unimpeachable as a record ; and, so far as we can discover, the compilers have here used both pains and judgment in testing the records of others, while their own experiences are recorded simply and faithfully. Thus a real step is gained in the collection of valuable material for that comprehensive work on the distribution of birds in these islands which we may hope to see in due time. There is no superfluous matter in this volume, and no

FIG. 1.—Bearded Tit feeding young.

attempt at fine writing ; and excellent paper, print and binding combine to make it a very pleasant book to handle. The half-dozen plates of Cheshire scenery are very effective, and nothing is wanting, unless it be a rather better map of the county.

The avifauna of Cheshire, as the authors remark, is surprisingly poor ; the county does not lie upon any regular line of migration. It is too far north for the nightingale, which has seldom occurred, though we note that it has been recorded by that excellent observer, Rev. C. Wolley-Dod. The lesser whitethroat, as might be expected, is not common, nor is the grasshopper warbler. We should have expected the pied flycatcher to be more common than seems to be the case ; the tree sparrow, a bird of peculiar distribution, has probably been often overlooked. The goldfinch and linnet are decreasing in numbers, but the opposite is the case with the turtle-dove. The list of waders, gulls, and birds of the coast, is not very large, and we regret to find that

the ubiquitous golfer is contributing to its further diminution. The characteristic bird of the county is a noble one—the great crested grebe, which is widely distributed ; and in dealing with it the authors have allowed themselves some half-a-dozen pages, which will be welcome to all ornithological readers.

Mr. Pike's little book bears the same relation to his photographs as a popular lecture does to its lantern illustrations : *i.e.* it is of secondary interest. Photography, applied to birds and their nests and eggs, seems to be a most attractive pursuit, leading its votary often to spend hours in the endeavour to catch a bird at some opportune and interesting moment, or to find the nest on which he has set his heart. It should certainly be useful in training the faculty of observation, and in assisting the memory ; and it may become a most welcome substitute for the predatory habits of private egg-collectors, who are perhaps the most dangerous enemies of our rarer birds. The actual contribution to zoology, however, does not seem as yet to have been great, and it is quite possible that before long we may have too many books on the subject. Mr. Pike's is, however, so unpretending and so pleasantly written, that it will no doubt be welcome to many beginners in ornithology who wish to learn where and how to look for nests, and a few of his experiences and his photographs will be interesting even to the more experienced. Part iv., on Norfolk birds, is perhaps the most valuable section of the book, and of the three photographs which Mr. Pike succeeded in taking of the nest of the bearded tit we select one for reproduction, as a favourable specimen of his work.

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS.

A CONGRESS of mathematicians was held at Chicago during the World's Fair ; but this was an isolated one. The series of international congresses was inaugurated at Zürich in 1897, and the second congress of this series met in Paris from the sixth to the eleventh of the present month. About 225 mathematicians of various nationalities, with 25 members of their families, were present. It had been expected that the numbers would be very much greater, as many as one thousand provisional acceptances having been received before last December ; the diminished attendance was doubtless due partly to the great heat of the preceding month, but probably in greater measure to the fear of exhibition crowds and exhibition extortions. It had been supposed that the Exhibition would attract people to the Congress ; on the contrary, it seems to have kept them away. The composition of the Congress was certainly international ; the numbers of members from the different countries were approximately as follows :—France, 90 ; Germany, 25 ; United States, 17 ; Italy, 15 ; Belgium, 12 ; Russia, 9 ; Austria and Hungary, 8 ; Switzerland, 8 ; England, 7 ; Sweden, 7 ; Denmark, 4 ; the remainder being from South America (4), Holland, Spain, Roumania, Servia, Portugal, Turkey, Armenia, Greece, Canada, Mexico, Japan.

The actual business was preceded by a *réunion* at the Café Voltaire, on the evening of August 5, when about half the members were present. The proceedings proper consisted of two general meetings on Monday and Saturday, with sectional meetings on the four intervening days. The opening general meeting had been announced for 2.30 p.m., August 6, in the Palais des Congrès in the Exhibition grounds : but unfortunately some action on the part of the Exhibition authorities necessitated changing the hour to the morning, and this change was decided upon too late to be communicated to all the members, many of whom had not even arrived in Paris at that hour. Thus a considerable number of the

members were unable to be present at the first general meeting, which was held on August 6 at 9.30 a.m. M. Hermite was acclaimed président d'honneur ; M. Poincaré, president ; the vice-presidents (some *in absentia*) were announced as MM. Czuber, Gordan, Greenhill, Lindelöf, Lindemann, Mittag-Leffler, Moore, Tikhomandritzky, Volterra, Zeuthen, Geiser. The secretaries were MM. Bendixson, Capelli, Minkowski, Ptaszycki, Whitehead ; the general secretary, M. Duporcq.

M. Poincaré, on taking the chair, spoke a very few words of greeting, and then called upon the speakers of the day. M. Cantor, in his address, " Sur l'historiographie des mathématiques," sketched the development of this subject through Montucla (toujours un modèle que tout historiographe des sciences doit suivre), Kaestner, Cossali, Bossut, Chasles, Libri, Nesselmann, Gerhardt, Arneth, Hankel, Boncompagni, up to authors of the present day. He expressed the firm conviction that the history of mathematics, from the beginning of Lagrange's work, can only be written as a series of special histories, with a final volume (Histoire des Idées) co-ordinating the whole. M. Volterra, " Trois analystes italiens, Betti, Brioschi, Casorati, et trois manières d'envisager les questions d'analyse," compared and contrasted the work of these three mathematicians, and considered the influence their differing lines of thought and expression have had on the development of Italian analysis.

Six sections had been arranged, with meetings extending over four days. While in general two sections were sitting at the same hours, yet matters were so arranged as to avoid, as far as possible, the conflict of interests that had been felt at Zürich, where only one day was devoted to the sectional meetings. These six sections, with their presidents and secretaries, were as follows :—

(1) Arithmetic and Algebra : Hilbert, Cartan ; (2) Analysis : Painlevé, Hadamard ; (3) Geometry : Darboux, Niewenglowski ; (4) Mechanics and Mathematical Physics : Larmor, Levi-Civita ; (5) Bibliography and History : Prince Roland Bonaparte, d'Ocagne ; (6) Teaching and Methods : Cantor, Laisant.

Owing, however, to the unavoidable absence on some days of the president of Section 5, and the small number of papers in that section, Sections 5 and 6 sat together, under the presidency, first of M. Cantor (Wednesday), and then of M. Geiser (Friday) ; and at the Wednesday morning sitting the two papers of most general interest in the Congress were read. These were Hilbert's address on the future problems of mathematics, valuable as assisting the mathematician to orientate himself, and Fujisawa's account of the mathematics of the old Japanese school, of special interest as giving information, not readily accessible otherwise, about a system of mathematics that is now entirely obsolete. It appears that the Japanese invented zero for themselves, and employed the circle as a symbol for zero ; that they used imaginaries and complex numbers, and calculated the value of π correctly to forty-nine places of decimals. In connection with this, M. Cantor remarked that the use of zero is probably Babylonian, and dates from about 1700 B.C.

M. Hilbert considered the origin and nature of the problems of mathematics the study of which is most likely to prove profitable ; the characteristics of a proper solution ; and the methods of attacking any problem that offers special difficulties. If the problem is really insoluble, then for the advance of mathematics it is essential that the impossibility be rigorously demonstrated. He illustrated his argument by means of selected problems that invite attack—problems regarding the axioms of arithmetic and of physics, prime and transcendental numbers, questions in the theory of functions, and the determination of the arrangement of the circuits that an algebraic curve can possess ;

referring to a paper about to appear in the *Nachrichten der Kgl. Gesellschaft der Wissenschaften zu Göttingen*, 1900, for a more complete list of definite problems that demand investigation.

Much interest was displayed in the papers read by M. Mittag-Leffler at the Tuesday morning sitting of Section 2, " Sur fonction analytique et expression analytique," " Sur une extension de la série de Taylor." The domain of an ordinary power-series is a circle that reaches to the nearest singular point ; at all points inside this there is convergence, at all points outside there is divergence ; this the author generalised so as to obtain a certain expression convergent within a particular region (an étoile), and divergent without. He raised the question whether an analytic expression can be found which shall represent, throughout its domain of definition, an assigned analytic function. A discussion followed between MM. Borel, Hadamard and Painlevé, as to the nature of the connection between " analytic expression in a complex variable x " and " analytic function in x." At the Thursday sitting of Section 1, M. Padé read a paper, " Aperçu sur les développements récents de la théorie des fractions continues " ; in this he showed the dependence of the expression of a function of x as a continued fraction on a certain diagram, in which each convergent is represented by a point whose co-ordinates are the degrees of the numerator and denominator of the convergent ; and, referring to the discussion that followed Mittag-Leffler's paper, suggested that a continued fraction may be found to be a suitable analytic form for any assigned analytic function.

The Friday morning combined sitting of Sections 5 and 6 was to a great extent occupied by the discussion of a resolution offered by M. Leau, urging the Academy to consider favourably the adoption of a universal language, not with a view to displacing any of the existing languages, but as a scientific medium auxiliary to these. Some such resolution has been brought forward lately on several similar occasions by the advocates of the latest artificial language, Esperanto. The discussion showed, on the part of mathematicians, very little sympathy with the suggestion, and very little recognition of a need for any such medium. As one speaker remarked, mathematics already has a universal language, the language of formulæ ; and the general sense of the sections was evidently that the existing diversity of languages need cause no real difficulty, so long as writers are willing to confine themselves to English, French, German and possibly Italian, this view of the case being formulated by a Russian, M. Vassilief. The only result of the discussion was the rejection of M. Leau's motion, and the recording of a wish that the Academy would discountenance any unnecessary diversity in the languages employed for scientific purposes. The four languages enumerated by M. Vassilief are those officially recognised in the meetings of the Congress, though it was noticeable that a great many of the speakers chose to speak in French, possibly out of compliment to their hosts.

Other communications of value, though of less general interest, were the following :—In Section 1, M. Stephanos, Sur la séparation des racines des équations algébriques ; in Section 2, M. Tikhomandritzky, Sur l'évanouissement des fonctions Θ de plusieurs variables ; M. Bendixson, Sur les courbes définies par les équations différentielles ; M. Jahnke, Zur Theorie der Thetafunctionen von Zwei Argumenten ; in Section 3, M. Lovett, On contact-transformations between the elements of space ; M. d'Ocagne, Sur les divers modes d'application de la méthode graphique à l'art du calcul ; M. Stringham, Orthogonal transformations in elliptic or in hyperbolic space ; M. Jamet, Sur le théorème de Salmon concernant les cubiques planes ; in Section 4, M. Hadamard, Relations entre les caractéristiques réels et les caractéristiques imaginaires pour les équations différ-

entielles à plusieurs variables indépendantes ; M. Volterra, Comment on passe de l'équation de Poisson à caractéristique imaginaire à une équation semblable à caractéristique réel ; in Sections 5 and 6, M. Padoa, Un nouveau système irréductible de postulats pour l'algèbre ; M. Capelli, Sur les opérations fondamentales de l'arithmétique. The attendance at these sectional meetings, all of which were held at the Sorbonne, varied from 50 to 120.

The concluding general meeting was held at the Sorbonne at 9 a.m. on Saturday. The proceedings opened with the sending of a message of greeting to M. Hermite, the président d'honneur of the Congress. It was then unanimously voted that the next Congress be held in Germany, in 1904, at the beginning or end of the summer vacation, the place mentioned as probable being Baden-Baden. M. Mittag-Leffler then delivered his address, "Une page de la vie de Weierstrass," and M. Poincaré spoke briefly on the "Rôle de l'intuition et de la logique en mathématiques," closing the proceedings immediately afterwards with the few words, "La séance est levée ; le congrès est clos."

On the conclusion of the Tuesday afternoon sectional meetings, members were received at the École Normale Supérieure, where a pleasant opportunity for social intercourse was enjoyed ; and at noon on the day after the closing of the Congress a banquet was held at the Salle de l'Athénée-Saint-Germain, when about 160 members sat down. In the absence of M. Poincaré, the proceedings were conducted by M. Darboux ; speeches were made also by MM. Geiser, J. Tannery, Stephanos and Vassilief. A considerable number of members of this and other scientific congresses accepted the invitation of Prince Roland Bonaparte to a scientific *soirée* on Saturday. A *fête* had been arranged by President Loubet for Thursday evening, but could not be held on account of the funeral of the King of Italy ; the invitations were consequently transferred to the *fête* in honour of the Shah on August 10.

It will be seen that very little business was transacted, apart from the reading of papers. At the joint sitting of Sections 5 and 6, it was asked what steps had been taken to put into effect the resolutions of the Zürich Congress as to the formation of a committee to consider certain questions of bibliography, &c., these having been adopted with the hope of ultimately consolidating mathematical enterprise, and directing it into profitable channels. No very satisfactory answer was forthcoming ; M. Laisant, on behalf of the French Mathematical Society, replying that they had done nothing in this line, having been entirely occupied with making material provision for the Congress. He drew the attention of members, however, to the announcement of the *Annuaire des Mathématiciens*, undertaken by Carré et Naud, 3, Rue Racine, which is designed to be a complete register of all mathematicians, with their addresses. It is much to be hoped that these questions, raised at Zürich, will be dealt with in a business-like manner at the Congress of 1904.

NOTES.

THE Scientia Club gave a banquet to Lord Kelvin during the International Physical Congress at Paris. M. Louis Olivier presided over a distinguished company, and speeches in appreciation of Lord Kelvin's scientific work were made by him and by Profs. Mascart and Cornu.

FROM the official report of the International Congress of Electricians at Paris, we see that two communications, by Mrs. Ayrton and M. Blondel, were received with great appreciation. Mrs. Ayrton's paper was on the luminous intensity of the electric arc with continuous current, and she showed that the best result, both from the point of view of luminosity and expenditure of energy, was obtained from an arc only a millimetre in length. Demonstrations in illustration of this conclusion, and showing the absorbing and cooling effects of carbon vapour produced in the arc, as well as the production and absorption of green and yellow radiations, were given by Mrs. Ayrton at a special meeting in the École supérieure d Electricité. M. Blondel reviewed the progress of electric lighting during the past ten years, and made some very valuable remarks on arc lamps with alternating currents, and on the carbons commonly used in arc lights.

IN opening the business of Section A (Mathematical and Physical Science) of the British Association at the forthcoming Bradford meeting, we understand that Dr. Larmor will review the change of ideas which has recently become current regarding the scope and method of physical explanation. The brilliant experimental verification of Hertz has led to the acceptance on the Continent of the views originated in this country regarding the nature of electric actions and their dependence on the æther ; but there has been a strong tendency to eliminate from the exposition of the theory those dynamical explanations which formed a main feature of its development in the hands of Clerk Maxwell. It is of fundamental importance to consider how far purely descriptive methods can thus avail towards an effective formulation of general physical theory, without appealing to a dynamical foundation of some kind. In all branches of the subject the discrete atomic constitution of matter is reached when we probe deep enough ; thus the method of representation of the physical activities of the material atoms, so far as they can be known to us, is of the essence of a dynamical treatment. This leads on to the cognate question, whether denial of direct action at a distance necessarily implies the passing on of all electric effects from element to element of the medium entirely by simple stress ; if that be too narrow a scheme, the efforts that have been made towards formulation on this basis were foredoomed to failure. The scope and limitations of the method of statistical enumeration of the activities of the atoms, which is the only one now available in ultimate thermodynamic discussions, depend on considerations of a different order. The modern extension of the range of the principle of Carnot also requires us to face the question how far the processes of chemical interaction between atoms, as distinct from the properties of the molecules when formed, are amenable to dynamical representation.—The general scheme for the business of the section is to take physical papers of a mathematical nature on Friday, September 7. On Monday, September 10, the section will divide into two, dealing with mathematics and meteorology respectively. On Tuesday a discussion on ions will be opened by Prof. Fitzgerald. It is also hoped to arrange discussions on the partition of molecular energy, and on the relation of radiation to temperature, under the thermodynamic aspect.

A PASTEUR Institute has just been opened at Kasauli, a hill station in the Punjab district, about thirty miles from Simla. It is thus no longer necessary for a person bitten by a rabid animal in India to journey to Paris for treatment by inoculation. The treatment at the Kasauli Institute is to be given free of charge.

PROF. J. C. BOSE, who has been attending the recent International Congress of Physics at Paris as the delegate of the Government of Bengal, will also attend the British Association meeting at Bradford in the same capacity, and will there describe some electrical investigations with which he has lately been engaged..

THE following international congresses upon scientific subjects will be held in connection with the Exposition at Paris during September : 3–8, History of Religion ; 3–5, Basque Studies ; 3–4, Pharmacy Specialities ; 10–16, Meteorology ; 10–12, Agri-